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CURRENT LIMITER
[TOKOOGRANICHITEL']

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(54) Current Limiter

(57) Abstract

A current limiter, which contains a housing, two solid metal electrodes, insulation plates with openings made in them, which form channels, whereby the insulation plates separate the inter-electrode space into cylindrical cavities, partially filled with liquid metal, and the channels located non-coaxially with respect to the cylindrical cavities is characterized in that for the purpose of increasing the nominal current, sensitivity and device speed, the opening in each of the two adjacent insulation plates are shifted with respect to one another toward the opposite walls of the housing.

The invention pertains to the technology of direct current electrical circuit switching, more specifically to liquid metal current limiters.

A current limiter is known that contains a housing, two solid metal electrodes, insulation plates with openings made in them that form channels, whereby the insulation plates separate the inter-electrode space into cylindrical cavities, partially filled with liquid metal, and the channels are positioned non-coaxially with respect to the cylindrical cavities. The channels have common axis of symmetry [1].

In order to increase the nominal current of the current limiter one must enlarge the channel cross section in the insulation plate. This leads to a decrease of the bulk magnetohydrodynamic forces in the liquid metal body and reduction of sensitivity and speed. Thus, with an increase of the current limiter nominal current its sensitivity and speed are lowered.

The aim of the invention is an increase of the nominal current, sensitivity and speed by use of additional electromagnetic forces brought about by the direction of current in the channels.

The established goal is achieved by the fact that in the current limiter, which contains a housing, two solid metal electrodes, insulation plates with openings made in them, whereby the insulation plates separate the inter-electrode space into cylindrical cavities, filled with liquid metal, and the channels are located non-coaxially with respect to the cylindrical cavities, the openings in each of the two adjacent insulation plates are shifted relative to one another toward the opposite lateral walls.

For this reason the current distribution in the liquid metal is such that current loops are formed. In this case not only pinch effect forces but additional electromagnetic forces, due to the current loops, act on the liquid metal fluid in the capillary channels. During passage through the device of the cut-off current the force of current interaction in the insulation plate channels with the magnetic field of the loop current increases, which passes in the large cross section channel.

$$F = B \times I,$$

Where I is the current;

B is the magnetic induction.

This force is directed toward the wall of the channel and promotes ejection of the liquid metal from it.

Thus, in nominal mode the indicated force is negligible and does not have an effect on the operating mode, but when there is a sudden increase of the current the speed increases and device sensitivity increases.

Figure 1 shows the current limiter, general view. Figure 2 shows A-A cross section in Fig. 1.

The current limiter consists of two solid metal electrodes **1** and **2**, press fitted into the insulation housing **3**. Insulation plates **4** and **5** with channels offset relative to one another toward the lateral walls of the housing are located in the housing **3**.

Inter-electrode cylindrical cavities **6**, partially filled with liquid metal, are formed between the insulation plates **4** and **5**.

The current limiter works in the following way.

In nominal mode magnetohydrodynamic forces act on the liquid metal fluid in the channels of the insulation plates **4** and **5**, the value of which is insufficient to disrupt the liquid metal fluid.

With a current increase to the cut-off current value of the current limiter the liquid metal in the channels will be influenced by the electrodynamic forces caused by the current loops, and these forces will press it to the walls of the channel of the insulation plates and will displace it from it, and simultaneously there will occur rapid heating of the liquid metal, which leads to its evaporation. Due to the action of pressure, vapors of liquid metal are sprayed into the larger spaces and, as they pass through the

liquid metal, which is found in the cylindrical cavities **6**, is cooled and condensed, and the positive pressure is compensated by the free spaces of the cylindrical cavities **6**. The deflection arcs that arise have reference spots on the liquid metal. The ceramic surfaces of the channels in the insulation plates **4** and **5** in this case are cooled by rapid removal of the flow of thermal energy of the electric arc by liquid metal in the cylindrical cavities **6**.

Thus, by the shift of channels in the insulation cavities to the lateral walls of the device such a configuration of current direction is created, for which an additional electromotive force acts on the liquid metal in the channels, which ejects liquid metal from these channels, which creates the possibility of increasing the cross section of channels in the insulation plates, that is to increase the nominal current of the device, while the sensitivity and speed increase.

The current limiter can be used to limit short circuit currents in high-power ship electric power generation units.

Two figures.

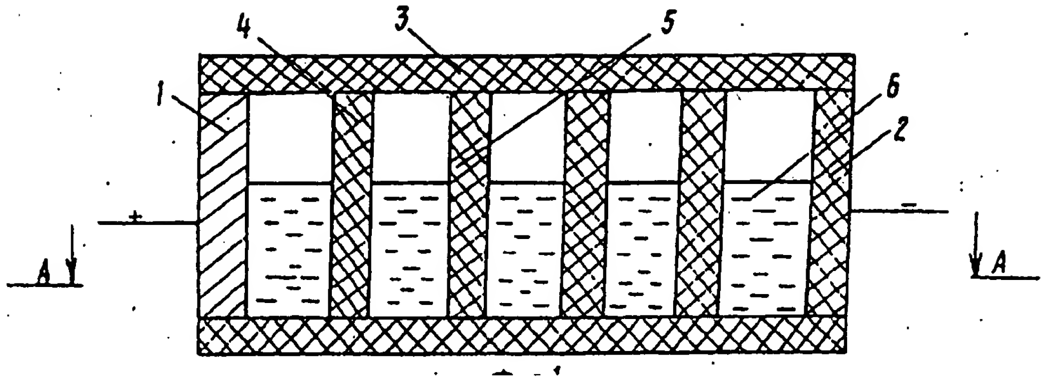

Figure 1

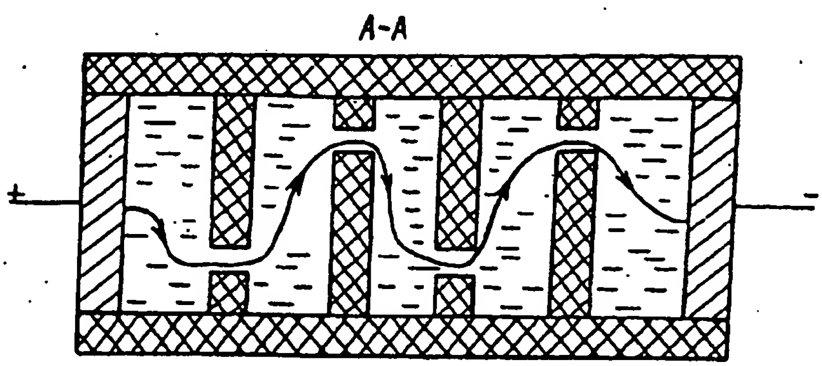

Figure 2